

## COLOR AS A COGNITIVE AND CULTURAL CODE: A PSYCHOPHYSICAL PERSPECTIVE

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### **Abstract**

This article explores color as a psychophysical phenomenon and as a cognitive-cultural code embedded in language and symbolic systems. Drawing upon neurophysiology, psychophysics, cognitive linguistics, and cultural semiotics, the study examines the biological mechanisms of color perception and the ways color terms acquire symbolic meanings across cultures. The findings demonstrate that while color perception is grounded in universal neural processes, its semantic and symbolic interpretations are culturally constructed. Thus, color operates simultaneously as a biological response to light stimuli and as a cognitive framework shaped by collective experience.

### **Keywords**

color perception, psychophysics, cognitive linguistics, color symbolism, cultural code, neurophysiology, semiotics.

### **INTRODUCTION**

Color perception is one of the most immediate and influential aspects of human sensory experience. From a physical standpoint, color corresponds to electromagnetic waves within the visible spectrum (approximately 400–700 nm) [5]. However, the experience of color is not inherent in light itself but is constructed by neural mechanisms in the human visual system.

The trichromatic theory of vision, originally proposed by Young and Helmholtz, states that the retina contains three types of cone receptors sensitive to short (blue), medium (green), and long (red) wavelengths [9]. This biological foundation is complemented by the opponent-process theory developed by Hurvich and Jameson, which posits three opposing neural channels: red–green, blue–yellow, and black–white [6]. These psychophysical mechanisms explain why certain color combinations are perceptually incompatible and why humans universally distinguish particular basic color categories.

Yet color is more than physiology. Berlin and Kay's cross-linguistic study demonstrated that languages tend to develop basic color terms in a universal

evolutionary sequence, suggesting a shared cognitive basis for color categorization [1]. Nevertheless, the semantic extensions and symbolic associations of these colors vary across cultures.

In classical Turkic intellectual tradition, for example, “Devonu lugotit turk” documents the social and aesthetic roles of color terminology. Likewise, in the works of Alisher Navoiy, colors function as metaphysical and ethical symbols. These examples confirm that color serves as a cognitive and cultural code embedded within linguistic structures[13].

The purpose of this article is to examine color as both a psychophysical process and a cultural semiotic system.

## **METHODOLOGY**

### **Neurophysiological and Psychophysical Foundations**

Scientific research confirms that color perception begins with photoreceptor activity in the retina. Cone cells convert light stimuli into neural signals transmitted to the visual cortex [2]. The opponent-process mechanism organizes these signals into contrastive channels, explaining perceptual phenomena such as afterimages and complementary color effects [3].

Neuroscientific studies indicate that color perception involves areas V1 and V4 of the visual cortex, where wavelength information is integrated and categorized [14]. Importantly, color constancy—the ability to perceive stable colors under varying lighting conditions—demonstrates that perception is not a passive reflection of physical reality but an active cognitive reconstruction [8].

Thus, color is not an objective property of objects; it is a neurocognitive interpretation of light stimuli.

### **Color and Emotional-Psychological Response**

Colors influence human emotions and behavior. Experimental psychology shows that warm colors (red, orange, yellow) increase physiological arousal, including heart rate and blood pressure, whereas cool colors (blue, green) tend to induce calmness [4].

The Lüscher Color Test suggests correlations between color preferences and psychological states [9]. Although debated, this approach highlights the symbolic projection of emotional states onto colors.

Research in environmental psychology further demonstrates that color affects perception of space, productivity, and mood [7]. For example, blue environments are associated with cognitive focus, while red may enhance attention to detail but increase stress levels.

These findings confirm that color functions not only as sensory input but also as a psychological stimulus.

## Color as a Cultural and Semiotic Code

From a semiotic perspective, color operates as a sign system. According to Umberto Eco, cultural symbols – including colors – gain meaning within structured sign networks [3]. Thus, color symbolism emerges from shared historical and social experiences.

For example:

- **White** symbolizes purity and innocence in Western Christian traditions but mourning and death in East Asian cultures [2].

- **Red** signifies passion and vitality in Europe, while representing prosperity and good fortune in Chinese culture [2].

- **Black** may symbolize evil and negation in Western contexts yet authority and elegance in modern global symbolism [11].

- **Green** represents renewal and life in many traditions but may carry negative connotations such as jealousy or betrayal in others [11].

These contrasting meanings illustrate that color symbolism is culturally encoded rather than biologically determined.

Cognitive linguistics explains this process through prototype theory. Eleanor Rosch argues that categories are structured around prototypical members rather than strict definitions [12]. Basic colors such as red, blue, black, and white function as cognitive prototypes from which metaphorical and symbolic meanings extend.

Thus, color terms are not merely descriptive labels; they encode conceptual and cultural knowledge.

## DISCUSSION

The interdisciplinary evidence suggests that color exists at the intersection of biology and culture. While neural mechanisms of perception are universal, the interpretative frameworks applied to colors are culturally specific.

This dual nature explains why colors often carry contradictory meanings. Red can symbolize love or violence; white may represent purity or death. Such ambivalence reflects the dynamic interaction between sensory perception and cultural narrative.

Therefore, color should be understood as:

1. A psychophysical response to light stimuli;
2. A cognitive categorization process;
3. A semiotic and cultural code embedded in language.

The present study supports the view that color perception is not a passive reflection of physical reality but an active neurocognitive construction shaped by physiological mechanisms, psychological responses, and cultural-semiotic frameworks. Neurophysiological evidence shows that photoreceptor activity in the

retina and subsequent processing in cortical regions such as V1 and V4 provide the biological foundation of color perception [2, 5]. The opponent-process mechanism accounts for contrastive perceptual phenomena, including afterimages and complementary color effects, indicating that color experience emerges from neural encoding rather than from objective properties of objects [3]. Moreover, the phenomenon of color constancy demonstrates that the visual system actively stabilizes perceptual experience across changing illumination conditions, reinforcing the interpretation of color as a cognitive reconstruction rather than a direct sensory imprint of wavelength information (land).

Psychophysical and experimental psychological findings further indicate that color exerts measurable effects on emotional and physiological states. Warm colors are associated with increased arousal (e.g., elevated heart rate and blood pressure), whereas cool colors tend to induce calmness and relaxation [4]. Environmental psychology research also suggests that color influences spatial perception, productivity, attention, and mood, with blue environments linked to cognitive focus and red associated with heightened attention to detail but potentially increased stress [7]. Although the Lüscher Color Test remains debated in terms of diagnostic validity, its continued application reflects broader interest in the symbolic and projective dimensions of color experience [9]. Collectively, these findings indicate that color functions not only as perceptual input but also as a psychological stimulus capable of shaping affective and behavioral responses in context-dependent ways.

Beyond biological and psychological mechanisms, the results highlight the culturally constructed nature of color meaning. From a semiotic perspective, colors operate as signs embedded within culturally shared systems of interpretation, as emphasized in the work of Umberto Eco [3]. Cross-cultural contrasts in the symbolism of white, red, black, and green illustrate that color meanings are historically and socially encoded rather than biologically fixed [2,11]. These variations challenge universalist interpretations of color symbolism and underscore the importance of socio-cultural context in shaping both perceptual associations and symbolic values. Consequently, any comprehensive account of color perception must integrate cultural frameworks alongside sensory mechanisms.

Cognitive linguistics provides an additional explanatory layer through prototype theory. According to Eleanor Rosch, categories are organized around prototypical members rather than strict boundaries [12]. Applied to color, this explains why certain hues are perceived as more representative of a category (e.g., a “typical red”), while others (e.g., pink or burgundy) are treated as peripheral extensions. This categorical structure supports the metaphorical and symbolic

expansion of color terms in language and discourse, indicating that color lexemes encode conceptual and cultural knowledge in addition to perceptual distinctions.

Taken together, these findings support an integrative model in which neurophysiological processes provide the sensory foundation, psychophysical mechanisms shape perceptual experience and emotional response [4,7,8], and cultural-semiotic systems assign symbolic meaning [3,11], with cognitive categorization structuring how color concepts are organized and extended [12]. This multidimensional understanding of color has practical implications for visual communication, design, marketing, and intercultural interaction, where strategic or inappropriate color use can significantly affect interpretation, emotion, and behavior. Future research may further examine how digital environments and artificial visual systems reshape color perception and symbolism, potentially transforming the relationship between sensory processing and cultural meaning.

### CONCLUSION

Color perception is rooted in neurophysiological processes but gains meaning through cognitive structuring and cultural symbolism. As a cognitive and cultural code, color shapes human interpretation of reality, emotion, and identity. Understanding color requires integrating psychophysics, neuroscience, cognitive linguistics, and cultural studies.

Future research may explore experimental cross-cultural studies on emotional responses to color terminology in multilingual contexts.

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